ETRTO
The European Tyre and Rim Technical Organisation

In coordination with

ETRMA
EUROPEAN TYRE & RUBBER manufacturers' association

Tyres and abrasion

Tyre Abrasion Rate measurement Vehicle method description

ETRTO proposal

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Objective

- **ETRTO aims to:**
  - Identify the most suitable test method(s) to measure abrasion rate for passenger car (C1) tyres
  - Develop and implement the test method(s)
  - Validate the final test method(s) and parameters
- **The final goal is to obtain a method measuring tyre abrasion rate:**
  - Representative of real driving environment
  - Repeatable, reproducible, cost efficient and practicable
  - Usable for regulation purpose (including market surveillance)
  - Open to all tyre manufacturers worldwide

ETRTO developed a first test method measuring tyre abrasion rate in real driving environment, using a convoy of vehicles including one vehicle equipped with reference tyres

Test method concept

- Test is done using up to 4 vehicles which are driven on public roads along a selected circuit with a given driving severity
- Tyres are evaluated in a relative sense vs. a reference tyre which is fitted on one of the vehicle in the convoy
- The measured performance is tyre mass loss for 1 tyre for a given service (distance & load carried), averaging the 4 tyres of the vehicle. Unit: mg/km/Ton or index relative to reference tyre
- Tyres (same SKU on one vehicle) are not rotating on vehicles (could be different tyres sizes on different vehicles)
- All tyres, including the reference one, experience the same
  - Weather,
  - Road conditions,
  - Speed and accelerations,
  - Positions and drivers in the convoy, as the vehicle/driver change relative position during the test
- Test is run for 8 000 km run to get a stabilized abrasion rate and a correct separating power
- Technical means:
  - Standard cars, tyre fitment workshop, scale to measure tyre mass, scale to measure vehicle mass
  - thermometer, speed/acceleration recording devices
- Test place : Public roads

Test conditions

- Type of roads
  - Representative of Highway driving style : distance 40% +5%/-5% with X std [0.18;0.53] Y std [0.32;0.78]
  - Representative of Regional driving style: distance 30% +5%/-5% with X std [0.34;0.78] Y std [0.52;1.46]
  - Representative of Urban driving style: distance 30% +5%/-5% with X std [0.42;0.80] Y std [0.54;1.27]
- Longitudinal (X) acceleration: max [5] m/s^2, for [99.8]% of distance, standard deviation 0.45 m/s^2 +/- 10%
- Lateral (Y) acceleration: max [5] m/s^2, for [99.8]% of distance, standard deviation 0.93 m/s^2 +/- 10%
- X and Y accelerations standard deviation during the test should not deviate by more than 5% from one vehicle to another vehicle of the same convoy
- X and Y accelerations standard deviation during the test for each cycle should not deviate from central circuit value by more than 5%, for 90% of the distance
- Speed should not excess legal limits, nor the 140 kph speed.
- Speed to be monitored, and should not vary from circuit average speed by more than 5%
- Circuit abrasion level for the reference tyre:
  - Summer reference tyre: circuit abrasion level @ 20 degrees should be in the range *[50,70]**mg/km/T
  - Winter reference tyre: circuit abrasion level @ 5 degrees should be in the range *[50,70]** mg/km/T

Note: * Values to be fixed after testing candidate reference tyres, end of 2022

Note : ** All the acceleration values in m/s2, calculation distance based as explain slide "Measurements and data treatment"

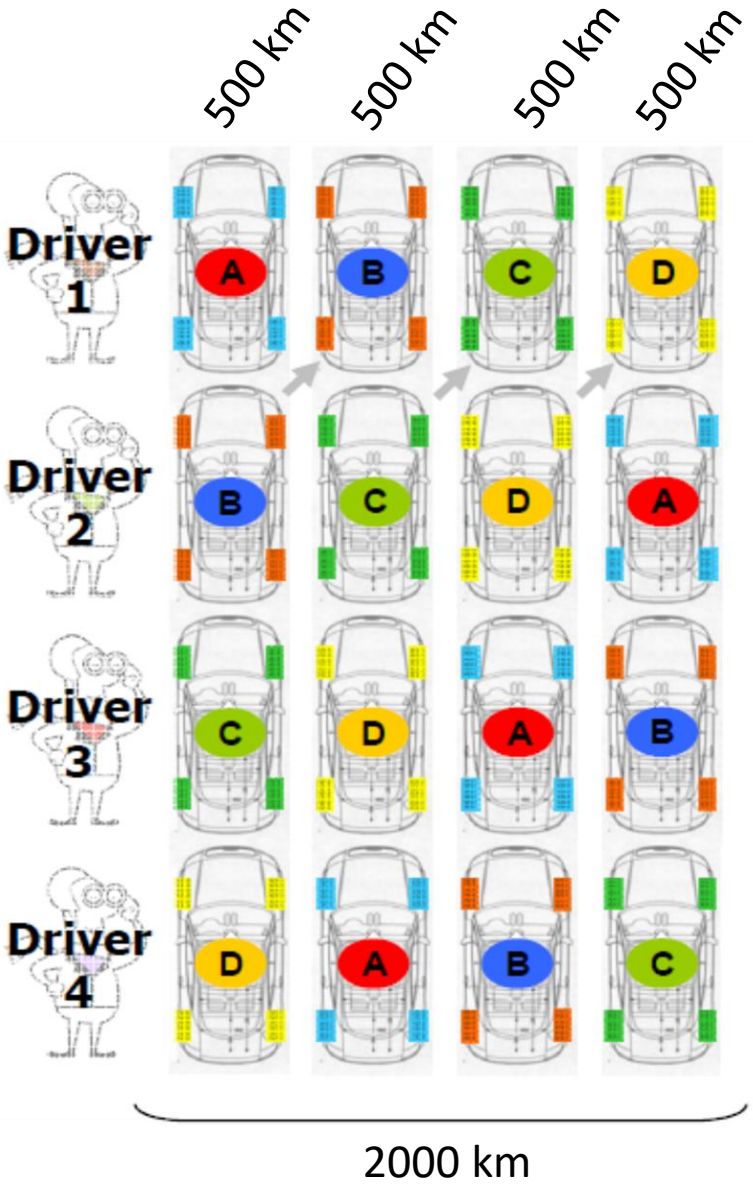
Test conditions

- **Tyre load**
  - The total vehicle mass should be between 60 and 75% of the total nominal tyre load capacity
  - For FWD vehicles: Front axle load 56% +/- 7%, Rear axle 44% +/- 7% of total vehicle mass
  - For AWD/RWD vehicles: Front axle load 50% +/- 7%, Rear axle 50% +/- 7% of total vehicle mass
- **Tyre pressure: nominal tyre pressure**
  - For normal load tyres: 250 kPa, all position
  - For extra load (incl HLC) tyres: 290 kPa, all position
- **Rim width :** 7.5" for reference tyres, tyre manufacturer authorized for tested tyres.
- **Testing temperature**
  - Normal tyres: average during whole test in [7;30] range, minimal 2°C, maximal 35°C
  - Severe Snow tyres: average during whole test in [0;20] range, minimal -5°C, maximal 25°C
- **Rain % <= 20%** (measured by whippers on time)
- **Vehicle constraints** (@ test conditions)
  - Aerodynamical perf. : A*Cd of vehicle with reference tyres <= 1.2 * A*Cd of vehicles of measured tyres
  - Driven axle test tyre : Toe 0° +/- 0.12 per wheel, camber 0° +/- 1 per wheel for FWD
  - Driven axle reference tyre : more strict?
  - Non driven axle: car maker specification

Convoy and vehicle management

- **Vehicles allowed in the convoy (from 2 to 4 vehicles):**
  - Same type of architecture (FWD, RWD or AWD) allowed in the same convoy
  - Same type of engine (ICE or EV) allowed in the same convoy

- **The convoy is managed aiming to expose each tyre model to same conditions during each shift:**
  - Be driven by each driver for the same distance
  - Experience the same distance in each position in convoy (lead, intermediate 1&2, last position)
  - For a convoy of 4 vehicles running 8000 km, each tyre model will be driven for 2000 km by each driver, and will be in each position in the convoy for a total of 2000 km
  - Example for a cycle of 2000 km with 4 shifts of 500 km:



Measurements on tyres and vehicles in workshop

- **Beginning of the test (0 km)**
  - Each tyre mass
  - Each tyre + wheel mass (without air) + balance masses
  - Balance mass
  - Vehicle mass per wheel, full tank, suspension tuning
- **During the test:**
  - Tyre pressure cold, each day
  - Recommended: 2 intermediate measurements (~2500km and ~6000 km depending on cycle length)
    - Each tyre + wheel mass (without air) + balance masses
    - Balance mass
    - Vehicle mass per wheel, full tank, suspension tuning
- **End of the test (~8000 km)**
  - Each tyre mass
  - Each tyre + wheel mass (without air) + balance masses
  - Balance mass
  - Vehicle mass per wheel, full tank, suspension tuning

Measurements and data treatment

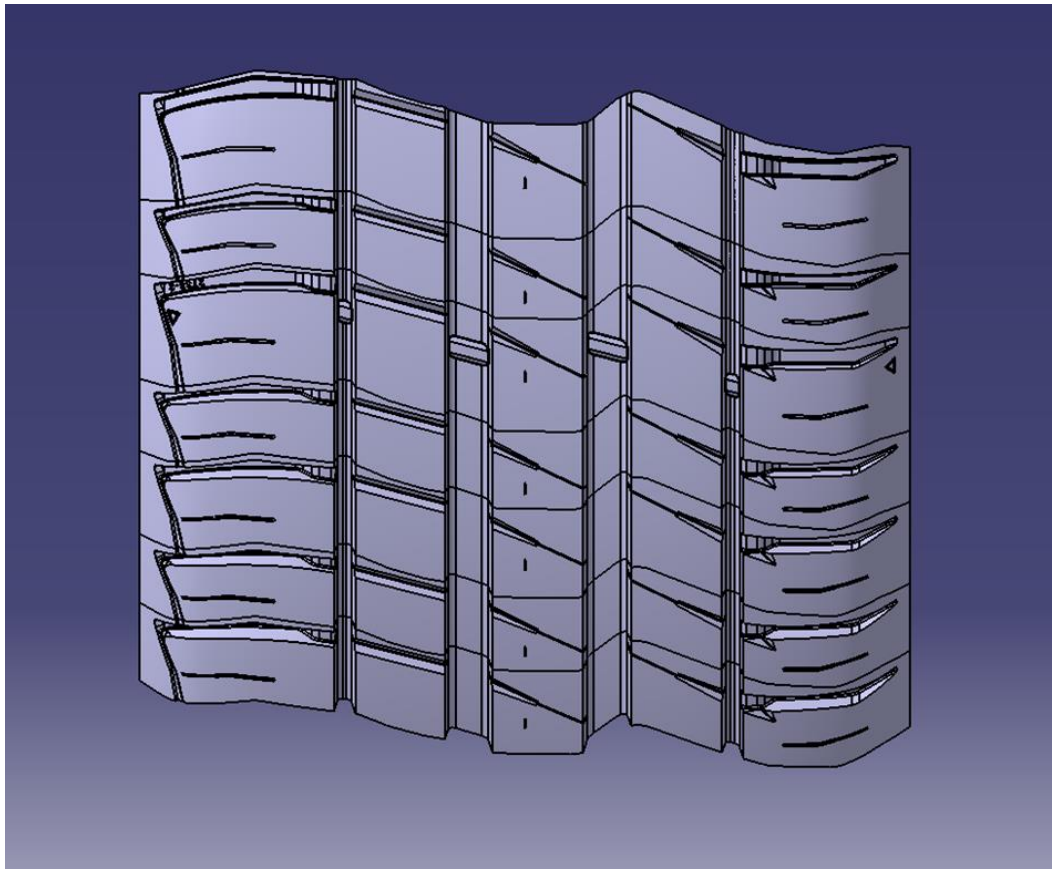
- **Measurement during the test:**
  - Temperature each day: beginning of test, intermediate 1, highest point, intermediate 2, end of test.
  - Continuous measurement of speed, lateral and longitudinal acceleration
    - Sampling rate recommended 10 Hz
    - Most common technology is GPS measurement
- **Data treatment**
  - Abrasion rate calculation: see slide 11
  - Temperature: average of the 5 ambient temperature measurements over the circuit
  - Accelerations:
    - Filter for measured Values: Butterworth filter (which order?) with a cut-off frequency of 1 Hz is used
    - Sliding average: over 1 second for longitudinal acceleration, all other values over 2 seconds.
    - Distance-based standard deviation:
      - Measured accelerations (sampled with a constant frequency) are transferred in distance-based values: one value per meter. For this a simple interpolation is used.
      - With these accelerations, the standard deviation can be calculated with usual standard deviation formulas.

Candidate Reference tyres (ongoing evaluation of performances)

- **225/45R17 94W XL**

Summer tyre pattern

From BFG Advantage



225/45R17 94H XL

Severe Snow tyre pattern (3PMSF)

From BFG G-Force Winter 2

Tyre performance measurement and normalization

1. The measured performance is a tyre mass loss average for a given service (distance and load carried) for the 4 tyres of the vehicle. Unit: mg/km/Ton or index
2. This performance is relative to a reference tyre performance, which is used to compensate measurement variations linked to climatic conditions, road surfaces, vehicle impact, traffic, driving style…
3. The performance is given as (indicator to use to be decided):

Example:

Data	Unit	Test tyre				Reference tyre			
Tyre position		FL	FR	RL	RR	FL	FR	RL	RR
Tyre load									
Tyre initial mass	g	10 398	10 349	10 347	10 338	9 022	9 019	8 990	8 972
Tyre final mass	g	10 126	10 057	10 268	10 241	8 793	8 769	8 917	8 882
Mass loss	g	272	292	79	97	229	250	73	90
Average mass loss per tyre	g				185				161
Test distance	km				8 000				8 000
Average tyre load	kg				402				402
Tyre measured abrasion rate during test	**mg/km/T**				**57.6**				**49.9**

Relative abrasion rate Test/Reference	**no unit**	**1.15**	**(lower it is, better is the tyre)**
Relative abrasion rate Reference/Test	**no unit**	**0.87**	**(higher it is, better is the tyre)**

Note: ETRTO is also considering if and how to test tyres equipping vehicles with different sizes on front axle and on rear axle and will propose possible options

ETRTO proposed tyre abrasion rate test method

- **Highly representative of real driving conditions**
  - Real test on commercialized vehicle on real public roads (Urban, Rural, Highway)
  - Speed, acceleration and climate conditions accurately selected *(Data Base from Tire Manufacturers in EU: main countries covered countries F+E+I+D+GB+ S, 3555 vehicles, 10 Market segments, 15 Millions of trips, 150 Millions of km)*
- **Accurate, Reproducible & Repeatable**
  - Evaluating tyres designed for different purposes (e.g. summer & winter) in the proper way
  - Accurate selection of circuits (test provider) and test conditions
  - Usage of different reference tyres to compensate difference in temperature, track, …)
- **Affordable**
  - open to stakeholders worldwide
  - reasonable time and cost for testing
- **Preparedness**
  - Test ready to be implemented, similar to current practice of test centers, Vehicle & Tyre Industry,…

Next steps

- **The method is ready to use**

- **However, it still needs to be qualified for its performance including:**
  - Separation power
  - Uncertainties

- **ETRTO and Tyre Industry have designed a measurement plan allowing to establish and prove the method precision/separation power uncertainties in 2023 Q1/Q2/Q3 and offer a set of data for correlation purpose**
  - 3 sizes, 11 pattern and 2 reference tyres
  - 4 convoys run on winter or summer candidate circuits
  - 4 repetitions @ different temperatures.

- **All the results and analysis should be ready summer 2023, as previously indicated**

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Many thanks for your attention